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AGRI-ENVIRONMENTAL INDICATORS: NITROGEN BALANCE AT NUTS IV LEVEL. A CASE STUDY IN GREECE

Paper submitted by National Statistical Service of Greece*

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Agri-environmental indicators: Nitrogen balance at NUTS IV level.

A case study in Greece

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ABSTRACT

The present work was carried out in the framework of the technical actions of the TAPAS program (Technical Action Plan for Agricultural Statistics) in order to improve the Agricultural Statistics of the European Union.

The development and application of a suitable methodology for establishing environmental indicators was the target of this action, according to the new approaches of environmental dimension of the Common Agricultural Policy, (CAP) of the European Union.

Agri-environmental indicator development is illustrated by a concrete case study of Nitrogen balance at NUTS IV (LAU1) level in Greece.

The nitrogen balance is a useful indicator of the risk posed to the environment from the excessive nitrogen. The LAU1 analysis of the N balance was made in order to identify areas of high surplus and thus were surface and ground water may be at risk.

To this end a 'step by step' methodology has been developed, using information from statistical databases and from Geographical Information System (GIS) in an attempt to answer this question. The problematic areas of Greece that are of high surplus can identified by implementation of this methodology achieving that specific policy measures for environmental protection at national level can be applied.

At the same time, this work can be considered as a useful tool following the reorientation of the (CAP), which is directed to transfer support from agricultural products to local incomes and encourages multi-operational and environmentally friendly activities.

1. INTRODUCTION

Agricultural practices affect in many ways the sustainability of water and soil resources. There are some negative impacts as a result of these practices, which mainly affect the agricultural land of plain areas where the natural and socioeconomic conditions favor intensive agriculture and to a lesser extent the semi-mountainous and mountainous areas.

It is well known that one of the main harmful impacts in the environment originating from the agricultural practices is caused by the excess use of fertilizers and pesticides. Excessive and unbalanced fertilization causes both environmental pollution and deterioration of the quality of agricultural products. Among fertilizers, the nitrates are soluble to water and therefore they are the most responsible for environmental pollution.

The present work deals with the development of indicators of nitrogen pollution at LAU 1 (Kapodistrian municipality) level, based on the cultivated agricultural land for each kind of crop grown and each kind of animal bred.

The usefulness of the analysis at this geographical level lies in the fact that a more precise detection of the problematic areas arising from the excessive use of fertilizers can be achieved so that the agricultural policy concerning not only the environment but the quality of the agricultural products as well will be more effective.

Chemical fertilizers are consumed today in huge quantities all over the world. In Greece, fertilizer consumption from 458,300 tons in1985 was fell to 261,000 tons in 2001 according to FAO data.

As it is already said, the excessive and unbalanced use of fertilizers causes serious damages not only to crops, but to environment as well. Referring to nitrogen, which is the most commonly used nutritional element for crops, it must be emphasized that a significant part of it escapes to the atmosphere in the form of several compounds. Among these, is the hypoxide of nitrogen, which significantly contributes to the destruction of the ozone layer.

It has been found that not only the nitrogen but some other nutritional elements, which are dissolved in rain and irrigation water, enter the surface and ground waters. This process is responsible for the phenomenon of eutrophism.

This is the background for adopting a policy incorporating environmental objectives in agricultural practices. The Directive of the EU dealing with nitrates (Directive for nitrate pollution 91/676) aims to reduce the quantities of nitrogen compounds in agricultural soils, as well as to avoid any further pollution of ground waters. This policy intends to reduce the present and future nitrogen pollution, and to measure the existing surplus nitrogen, by means of a nitrogen excess indicator as it has been established in the documents COM(2000)20 and COM(2001)144. This indicator is an indispensable instrument for distinguishing sensitive regions regarding nitrogen pollution.

Although there is no linear relationship between the excess of nitrogen and the nitrate salts in water, the risk of nitrogen diffusion is higher when local nitrogen excesses are high. For this reason, the estimation of nitrogen excess at local level is necessary for any assessment related to soil waters and the protection of natural recourses. The estimation of N balance represents an indicator of agricultural sustainability.

2. METHODOLOGY AND DATA SOURCES

The aim of this project was to introduce an analytical tool using Geographical Information System and statistical data available from existing surveys (Farm Structure Surveys and the Agricultural Census) in order to measure the impact of agricultural activities to the rural environment. The study focused on the nitrogen balance from agricultural activities, at LAU1 level, as an indicator of the risk posed to the environment from excessive nitrogen. The

LAU1 analysis of the Nitrogen balance made in order to identify areas of high surpluses and thus where surface and ground water may be at risk.

2.1. Methodology of nitrogen balance estimation

The nitrogen balance provides useful information regarding the state of nitrogen surpluses.

In the DPSIR context, the agricultural surpluses constitute a key stage, analogue of raw pollution depended on the yield of the activity. It therefore constitutes a pressure.

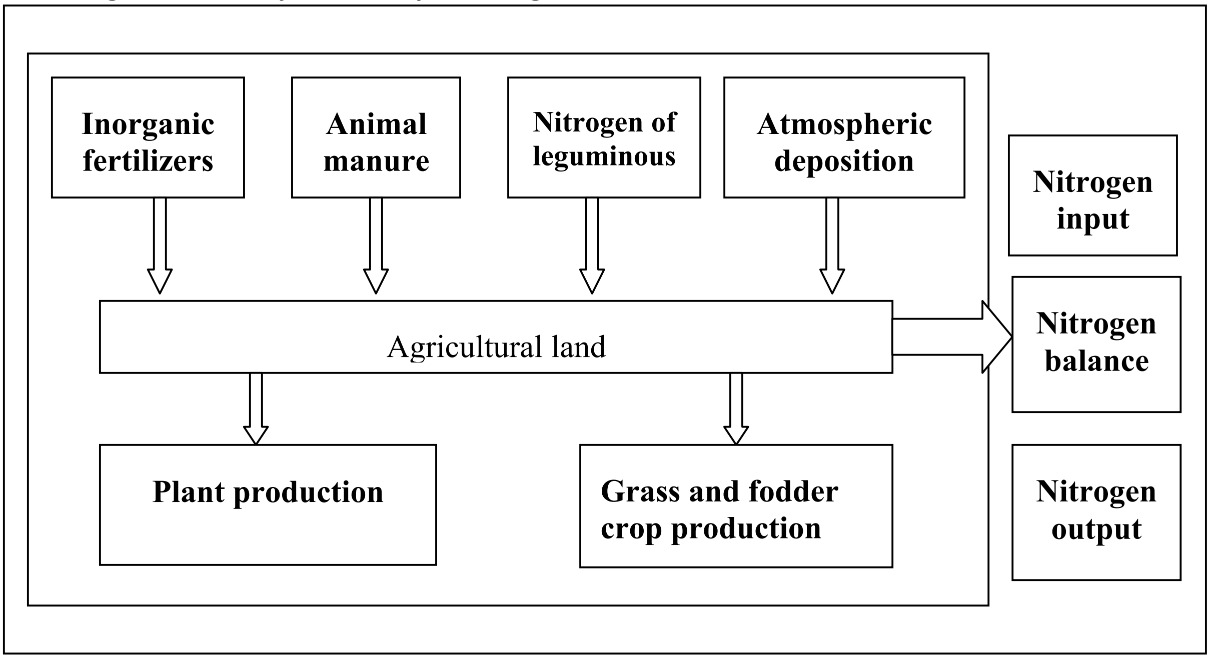
The nitrogen balance at the soil surface is defined as the difference between the total quantity of nitrogen inputs to the soil surface and the quantity of outputs that are released from the soil, annually. (Figure 1)

Nitrogen Balance = N input – N output = N held by the soil + N removal from the soil.

The total quality of **nitrogen inputs** to the soil during the process of agricultural production are those coming from mineral fertilizers and organic manure applied to agricultural land, the fixation by leguminous crops and the wet and dry deposition from the atmosphere.

The output (removals) of nitrogen are defined as the nitrogen content of crops removed from the field by harvest or by grazing.

Figure 1: Terms of the soil surface Nitrogen balance



It is understood that the above estimates are derived by using nitrogen data related only to agricultural practices within the utilized agricultural land. Pollution data referring to industrial wastes, mining activities and urban wastewaters is not included.

2.2. Data Sources

The data sources were used in the context of this project were:

a. Farm Structure Survey: Statistical data on cultivated areas by kind of crop and on number of animals at LAU1 were derived from the Basic Surveys of the year 1991 and 1999/2000

b. Annual Agricultural Statistical Survey: Statistical data on crop yield by kind of crop at LAU1 level were derived from a national survey using administrative sources.

c. The Greek map of Land Cover /Use, based on the Corine Land Cover project: A data base consisting of 16 categories of land cover. These data originated from processing of satellite images and the CORINE program. This file was used mainly for estimation of nitrogen absorbed by pastures for animal grazing.

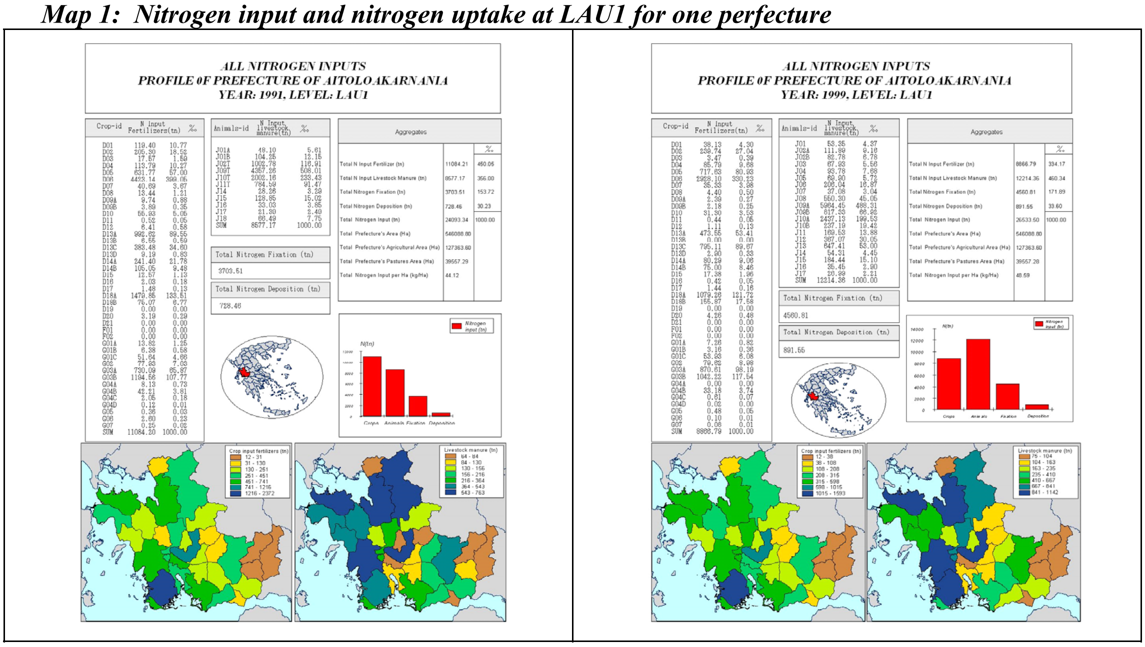
d. Natura areas:

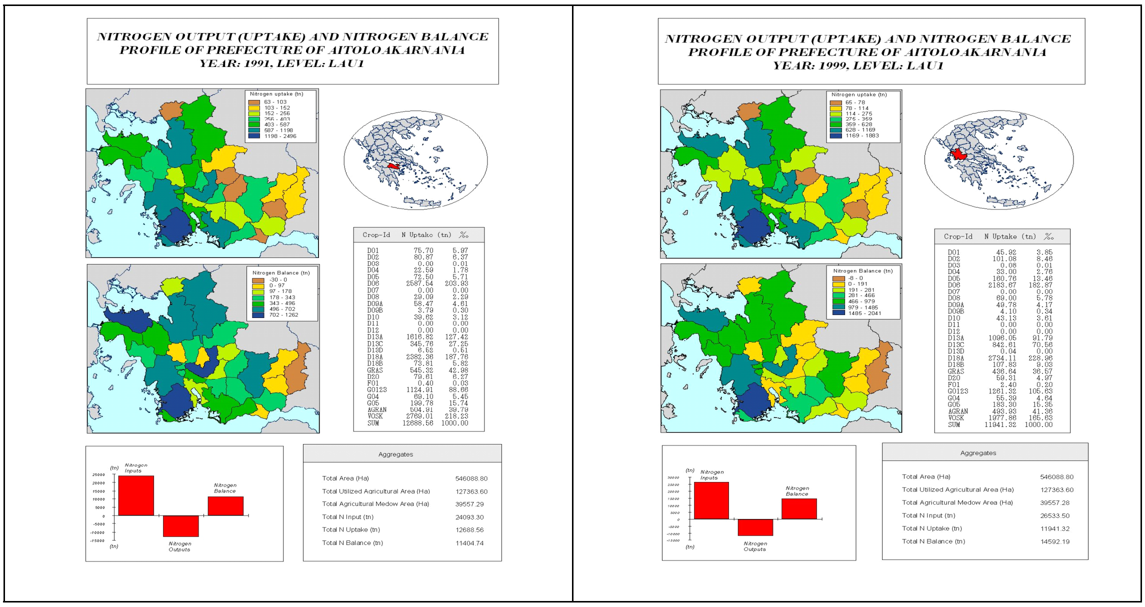
This was a GIS file of natura areas which is a complementary one, and gives to the users the ability to overlay all the other information with that of sensitive areas.

2.3. Data Base Construction

The above files have been organized and processed into a uniform application of GIS with spatial level of reference the Kapodistrian municipality (LAU1). In this way it is possible to produce maps of the profile of each prefecture (NUTS III) as well as of the country for input, output and nitrogen balance of the agricultural areas of the country.

Map 1: Nitrogen input and nitrogen uptake at LAU1 for one perfecture





The component of the geographic information system which has the most fundamental role and at the same time the highest cost is the database. It constitutes the sound foundation on which GIS users, utilizing the different tools at their disposal, can program and build an application and analyze and export the secondary data which can then be used to assist decision-making.

The basis of the geographic information system as set up to cover the needs of the project can be built on progressively in order to meet the future needs of the National Statistical Service of Greece, public administration overall, and even of the market in general with regard to issues relating to the environment and rural development.

A methodological approach was adopted in the development of the GIS, covering predominantly the stages of building the information database and integrating the system.

The database is structured as follows:

The data are stored in primitive form, i.e. the most basic simple form that they can take (points, lines, polygons, each correlated with topological and other characteristics).

The relationships between the data are included in the information base. Both the topological the natural and the socio-economic dimensions of the data are stored as their characteristics, so that the information can be composed, analyzed and interpreted in a wide variety of ways.

The design and build of the database allow the structured information to be updated.

At the analysis stage, the territorial information was structured and configured. Thus the data, previously in the form of primary material in the database, were processed to produce secondary data in the form of new thematic levels, graphics and indicators in tables. This material is intended as the background against which decisions can be made on rural issues - regional planning and management in the agricultural regions. It is the material that will show where there are shortcomings in the infrastructures of the agricultural area, which agricultural regions present an environmental interest, what are the interdependences and the causes of environmental degradation.

The different sections of GIS, which can combine territorial and non-territorial data, and its capability of mutually covering the various thematic levels of information and of creating new secondary data with various methods of interpolation and interconnection, in combination with the various methods of recovering information that the database uses, unite to make it the foundation of the search program.

The output stage, where the product of the analysis resulting from the previous stage was selected and made comprehensible using the presentation tools, which are supervisory, easy to understand and allow comparisons to be made between the results. Thematic, agri-environmental maps, comparative tables, graphics and diagrams were thus produced.

The following data were used to set up the database:

- Local administrative boundaries from 1991 up to the implementation of Law 2539/97 (Kapodistrias scheme). Polygonal – Linear Database. *.shp format
- Biophysical land cover (CORINE LAND COVER) scale 1:100.000. Polygonal Database. *.shp format
- Types of habitat (NATURA). Polygonal Database. *.shp format
- Statistical data from the records of the National Statistical Service of Greece. *.xls , *.sav format.

The data were processed in EGSA 87, the modern coordinate system common to the whole country.

3. RESULTS

Nitrogen input due to the consumption of mineral fertilizers is estimated at LAU1 level using the cultivated areas per kind of crop at this level from the FSS and relevant coefficients of nitrogen inputs from chemical fertilizers. (map 2)

To estimate the nitrogen input the technical coefficients of Eurostat for the year 1997 were applied.

An adjustment of the technical coefficients taking into account the changes of their consumption through time was made.

According to the above estimation about 32% of nitrogen fertilizers are used in winter cereals, 16% in maize, 14% in cotton and 17% in olive trees. (map 2)

Nitrogen input due to livestock manure is calculated as a function of the number of animals present at the reference day of the FSS at LAU 1 level and the appropriate coefficients of nitrogen inputs from livestock manure. (map 3)

According to the above estimation about 44% of the estimated nitrogen charge from manure is due to sheep breeding, 25% to goat breeding and the rest to other categories of animals.

It is worth to notice that animal husbandry is of small size in Greece in comparison with other European countries and equally limited are the problems of pollution that it generates.

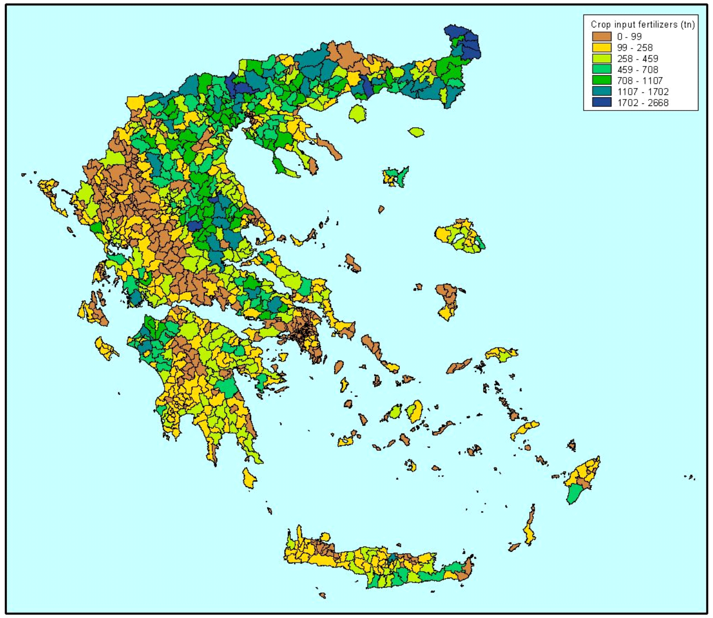
According to the existing National Legislation livestock effluents cannot be applied directly to the land without wastewater treatment.

The problem of pollution from this category of pollutants is geographically localized in certain regions of the country where there is concentration of livestock farms of middle or large size. These regions are:

- Prefecture of Evia (mainly around Artaki and Chalkida)
- Prefecture of Attiki (mainly in the areas of Megara, Aspropyrgos and Messogia)
- Prefecture of Thessaloniki (Neochoroutha, Pentalofos)
- Prefecture of Korinthia
- Prefecture of Ioannina (around the lake Pamvotitha)
- Prefecture of Arta and Preveza (in the watersheds of the rivers Louros and Arachthos)
- Prefecture of Larissa
- Prefecture of Aitoloakarnania (around the lake Trichonis)

Map 2

CROP INPUT FERTILIZERS
YEAR: 1999, LEVEL: LAU1



Disrtibution per kind of crop

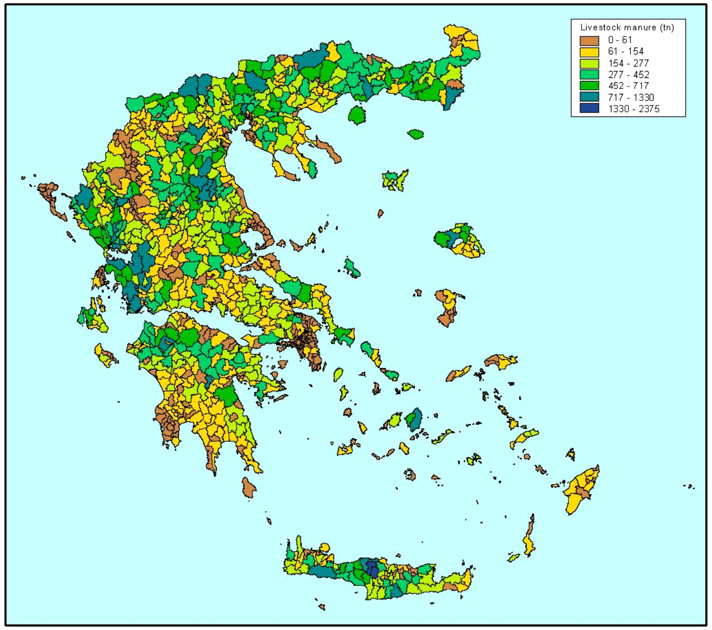
Crop-id	N Input Fertilizers(tn)	‰
D01	18132.03	55.44
D02	60172.92	206.79
D03	2125.04	7.30
D04	9700.36	33.34
D05	5667.43	19.48
D06	45898.53	157.73
D07	1815.37	6.24
D08	336.88	1.16
D09A	349.03	1.20
D09B	330.08	1.13
D10	5144.00	17.68
D11	4785.87	16.45
D12	34.65	0.12
D13A	2619.39	9.00
D13B	0.00	0.00

Crop-id	N Input Fertilizers(tn)	‰
D13C	39597.56	136.08
D13D	3868.25	13.29
D14A	7356.68	25.28
D14B	5038.40	17.31
D15	655.01	2.25
D16	48.50	0.17
D17	47.73	0.16
D18A	8180.59	28.11
D18B	2750.65	9.45
D19	0.00	0.00
D20	276.57	0.95
D21	0.00	0.00
F01	0.00	0.00
F02	0.00	0.00

Crop-id	N Input Fertilizers(tn)	‰
G01A	5058.07	17.38
G01B	193.52	0.67
G01C	2725.84	9.37
G02	1374.06	4.72
G03A	5815.52	19.99
G03B	45689.56	157.01
G04A	768.11	2.64
G04B	2832.61	9.73
G04C	981.72	3.37
G04D	2234.81	7.68
G05	47.14	0.16
G06	333.80	1.15
G07	4.47	0.02
SUM	290990.84	1000.00

Map 3

NITROGEN INPUT LIVESTOCK MANURE
YEAR: 1999, LEVEL: LAU1



Disrtibution per kind of animal

Animals-id	N Input livestock manure(tn)	‰
J01	2218.10	12.04
J02A	2668.97	14.49
J02B	1739.85	9.44
J03	2928.73	15.90
J04	2162.01	11.73
J05	803.24	4.36
J06	3161.95	17.16
J07	11226.89	60.94
J08	5681.71	30.84
J09A	73212.71	397.37
J09B	6441.29	34.96

Animals-id	N Input livestock manure(tn)	‰
J10A	43718.68	237.29
J10B	3439.20	18.67
J11	1216.79	6.60
J12	3402.98	18.47
J13	7256.88	39.39
J14	4697.18	25.49
J15	5497.08	29.84
J16	2097.39	11.38
J17	671.85	3.65
SUM	184243.46	1000.00

Fixation by leguminous crops and clover was estimated using data on cultivated areas by kind of leguminous crops as they appear in the file of the national annual agricultural survey that contains more analytical data at LAU 2 level and a relevant fixation rate by kind of crop. The data aggregated at LAU 1 level for all categories of leguminous crops. The total quantity of nitrogen fixation from legumes was estimated at 35,704.22 tons. (map 5)

Nitrogen deposition to agricultural land is estimated using data on the utilized agricultural area from the FSS which multiplied by the factor 7 Kg/ha. The outcome is that the estimated total quantity of nitrogen deposition in the utilized agricultural area amounts to 25,082.30 tons. (map 5)

The nitrogen absorption from harvested crops (output) is estimated using the data of the volume of the production by kind of crop at LAU2 level which aggregated to LAU1 level from the national Annual Agricultural Statistical Survey and the appropriate coefficients of N content of the harvest crops for each kind of crop.

From the above data it appears that the bigger absorption is due to the grazing pastures and, in a descending order, to tree crops, cotton, winter cereals and maize.

The estimation of the nitrogen absorption from areas under grass was based on the areas registered as pastures for animal grazing at the Greek map of Land Cover / Use which used the Corine Land Cover program.

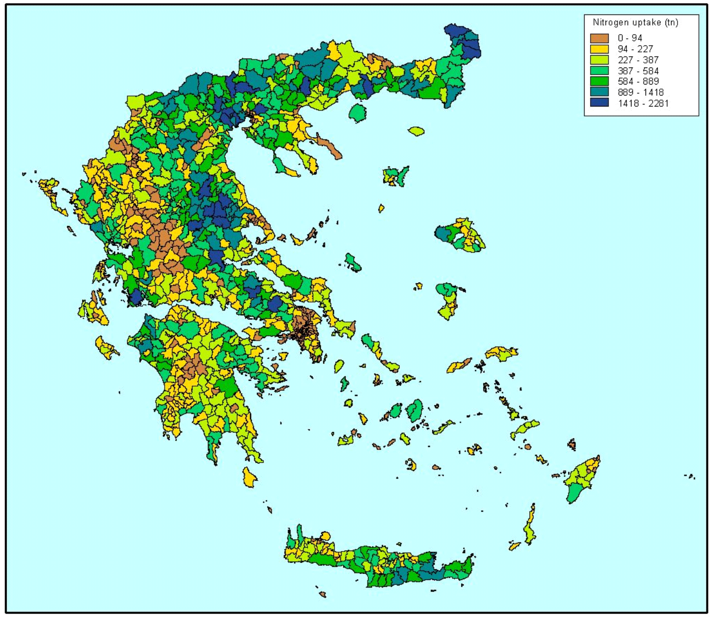
The nitrogen balance of the year 1999 is presented in the table 1 as well as at map 5.

Table 1: Nitrogen balance estimations for Greece in 1999

	Tons N
From crops	290,990.84
From animals	184,243.46
Atmospheric deposition	25,082.30
Biological process of legumes	35, 704.22
Total input	535,997.72
Total output	332,535.12
Balance	203,462.60

Map 4

NITROGEN OUTPUT (UPTAKE)
YEAR: 1999, LEVEL: LAU1



Disrtibution per kind of crop

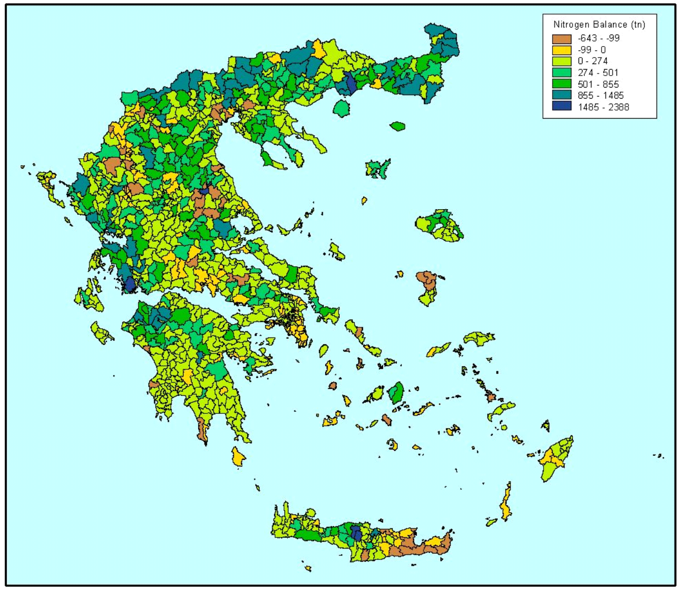
Crop-Id	N Uptake (tn)	‰
D01	9171.25	27.58
D02	32864.81	98.83
D03	445.85	1.34
D04	4309.30	12.96
D05	1553.93	4.67
D06	30057.71	90.39
D07	1273.24	3.83
D08	2289.34	6.88
D09A	1099.97	3.31

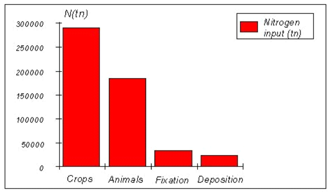
Crop-Id	N Uptake (tn)	‰
D09B	519.97	1.56
D10	3448.94	10.37
D11	4836.65	14.54
D12	17.51	0.05
D13A	5928.06	17.83
D13C	43750.10	131.57
D13D	1427.15	4.29
D18A	19458.33	58.52
D18B	16789.85	50.49

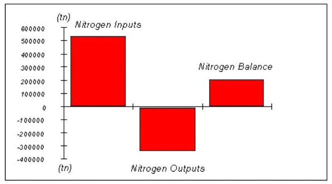
Crop-Id	N Uptake (tn)	‰
GRAS	2997.76	9.01
D20	1894.10	5.70
F01	113.81	0.34
G0123	49295.73	148.24
G04	9264.70	27.86
G05	8821.16	26.53
AGRAN	8786.11	26.42
VOSK	72121.78	216.88
SUM	332535.12	1000.00

Map 5

NITROGEN BALANCE
YEAR: 1999, LEVEL: LAU1







Aggregates		‰
Total N Input Fertilizer (tn)	290990.84	542.90
Total N Input Livestock Manure (tn)	184243.46	343.74
Total Nitrogen Fixation (tn)	35704.22	66.61
Total Nitrogen Deposition (tn)	25082.30	46.80
Total Nitrogen Input (tn)	535997.72	1000.00
Total Nitrogen Uptake (tn)	332535.12	
Total Nitrogen Balance (tn)	203462.60	
Total Greece's Area (Ha)	13197070.21	
Total Agricultural Area (Ha)	3583138.16	
Total Pastures Area (Ha)	1442564.30	
Total Nitrogen Balance per Ha (kg/Ha)	40.48	

4. DISCUSSION

Similar studies have been made in the past by J. M. Terres et. al. (2001)-IRC/IES Land Management and by J. Hansen (2000), Eurostat

The first work refers to all EU countries at the level of NUTS 2 and NUTS 3 by applying technical coefficients of EUROSTAT of the year 1997, using data of the Farm Structure Surveys for the years 1990, 1993, 1995 and 1997. According to our point of view the non-adjustment of the technical coefficients by this work has a serious effect on the conclusions concerning the changes in nitrogenous fertilizers use through time.

The best approach of this problem is to find an objective procedure for the adjustment of technical coefficients.

The method of adjustment used by J. Hansen, which is adopted by the present work refers to the adjustment of technical coefficients concerning the use of nitrogenous fertilizers according to the changes through time of their total consumption.

The second work estimates the nitrogen balance also at in NUT 3 level for the entire EU.

The aggregated results of the above-mentioned works for Greece are presented in the following Tables 2 and 3:

Table 2. Nitrogen balance for Greece, 1997 according to J. Hansen methodology

	Kg/ha	Tons of N
Total agricultural land 3486 th Ha		
Nitrogenous fertilizers for crops	88	306768
Organic fertilizers (manure)	49	170814
Nitrogen fixation from leguminous crops	2	6972
Atmospheric deposition on agricultural land	7	24402
Total (input)	146	508956
Nitrogen absorption from crops (F(q))	29	101094
Nitrogen absorption from hay, pastures, etc.	69	240534
Nitrogen balance	48	167328

Table 3. Nitrogen balance estimates for Greece, 1991 according to M. Terres et al methodology

	Kg/ha	Ton of N
Total agricultural land 3486 th. Ha		
Nitrogenous fertilizers for crops	76.94	250703
Organic fertilizers (manure)	12.84	41850
Nitrogen fixation from leguminous crops	-	-
Atmospheric deposition on agricultural land	18.33	59723
Total deposition (input)	-	352276
Nitrogen absorption from crops (F(q))	60.66	197647
Nitrogen balance	47.46	154629

The previously mentioned works are based on the following assumptions:

1. For the estimation of the nitrogenous fertilizers consumption, sampling data about the land area and the number of animals are used, originating from the Farm structure surveys of (1990, 1993, 1995 and 1997). As a result of the above process, significant sampling errors are involved in all estimations.
2. At the first study, the technical coefficients for the quantities of fertilizers used were the same for all years for each crop. This treatment ignores changes in farming practices as these are profoundly reflected in the overall consumption of fertilizers.
3. For the quantity of nitrogen absorption from grasslands and pastures, indirect calculations based on animal needs in grass (harvested or not) are used and not primary data.
4. The nitrogen fixation into the soil is underestimated in the case of legumes as many of them, mainly those used for feeding animals are not presented as a separate category in the Farm Structure Surveys.
5. Both studies deal with the establishment of nitrogen balance at NUT 3 level and for this reason good agricultural practices are not attainable in lower geographical level.

The present work uses agricultural census data in order to avoid problems due to sampling errors of the farm structure surveys. Also, the technical coefficients of EUROSTAT of the year 1997 are adjusted in the case of the nitrogen fertilizers usage for the years 1991 and 1999, in accordance with their total consumption in the reference years.

The geographical level of the present work is LAU 1 (Kapodistrian municipality). Therefore, data on agricultural production from the national survey the Annual Agricultural survey pertaining to LAU 2 level, were used for deriving the absorption of nitrogen. This made unnecessary the assumption of the same productivity at NUT 3 and LAU 1 level for each product. Also, the desire for more accurate estimation of the quantity of grass was satisfied, because the Annual Agricultural survey includes analytical reference to all relevant crops producing fodder plants for grazing within the utilized agricultural area, which is the object of the research.

The same files give detailed data for all kinds of legumes and, as a result, the estimation related to nitrogen fixation in the soil is more accurate.

The estimation of forage produced outside the agricultural land was performed in the present work by using the special survey of National Statistical Service of Greece (NSSG), referring to the 16 agricultural land utilization specified by a special GIS processing. The areas under pastures deriving from this source are estimated to be about 1.4 million hectares. We assume that this area is used for grazing of animals.

Comparing to the above mentioned work, it could be concluded that the present results are closer to Hansen's approach rather than Terres's one. For instance, Nitrogenous fertilizers for crops counts 306.768 tones of Nitrogen in Hansen's work, which is very close to the value in the present study (290.990,84 tons). Balance of N is estimated equal to 203.462,60 tons in the present study, value that is closer to Hansen's one (107.328 tons).

The advanced methodology applied in the present study provides the confidence of accurate estimations of Nitrogen balance. Additional work will be done to extent the estimations and to improve the methodology.

5. CONCLUSIONS

The present work, which was undertaken in the framework of TAPAS program, developed an accurate and innovated methodology in order to produce an important agri-environmental indicator such as the 'Nitrogen balance' is. A first strong point of the methodology applied is the detailed geographical level (NUTS IV), which is able to identify areas of high nitrogen surplus and so, permits the implementation of a specific policy for the environmental protection. The whole process is highly supported by a detailed information data base and by the establishment of a G.I.S. environment.

Additionally, the data were free from sampling errors as they come mainly from the basic surveys of 1991 and 1999/2000, and thanks to this the results derived are of higher precision. At last but not least, the technical coefficients concerning the use of nitrogenous fertilizers are adjusted taking into account the changes of their consumption through time, a methodology approach which produces more precise conclusions on the changes in nitrogenous fertilizers use through time.

The methodology applied and the instruments used, produce estimation of nitrogen input to soil surface as well as the outputs that are released from the soil using statistical data from existing surveys and relevant coefficients of Eurostat and other organizations in order to produce the Nitrogen balance of the year 1999 for Greece.

Interesting results are extracted for the areas of Greece which have a higher problem of pollution by category of pollutants.

As a concluding remark, it could be stressed out that a powerful and informative tool was constructed through this project, which can continuously support policy making in agri-environmental matters.

REFERENCES

1. Psilovikos, A. (1990). *Changes in Greek wetlands during the 20th century: Impacts on the inland waters of Macedonia and the river Delta of seashores of Aegean and Ionian seas. Protection and management of Greek wetlands.* Aristotle University of Thessaloniki.
2. Hansen, J. (2000). *Nitrogen balances in Agriculture, Statistics in Focus, Theme, 8-16/2000,* Eurostat
3. OECD (2001). *Environmental Indicators for Agriculture, Methods and Results*.
4. Terres, J.M.; Campling, P.; Vandewall, S.; VanOrshoven, J. (2001). *Calculation of Agricultural Nitrogen Quantity for EU River Basins, European Commission*, JRC.
5. Setatou, S. and Simonis, A. (1991). National Agricultural Research Foundation (NAG)
6. Crouzet, P. (2000). *Agricultural statistics spatialisation by means of Corine Land Cover to model nutrient surpluses*, European Environmental Agency, 14p.
7. Gallego, J.; Kayadjanian, C.; Vidal, C. (2001). *Geographical use of statistical data: Methodological overview.* Towards agri-environmental indicators – Integrating statistical and administrative data with land cover information. Topic Report 6/2001. European Environment Agency.
8. OECD (2001). *Extract from OECD publication: Environmental Indicators for Agriculture Volume 3: Methods and Results*, 32p (Doc AGRI-ENV/FEB01/2.1A-EN)
9. Brussels, 26.01.2000, Com(2000), 20
10. Brussels, 20.03.2001, Com(200), 144
11. National Statistical Service of Greece, ‘Land Use indicators and agro-environmental Statistics’ – Final report, forum.europa.eu.int/members/irc/dsis/rural_dev_statistics/library